REMARKS

This paper is being provided in response to the Office Action mailed November 26, 2003, for the above-referenced application. In this response, Applicants have amended claims 1, 7, 8, 10, and 17 and added new claim 21 to clarify that which Applicants consider to be the invention. Applicants respectfully submit that the amendments to the claims and the new claim are fully supported by the originally-filed specification.

Applicants thank the Examiner for the indication of allowable subject matter in claims 7-9 and 17-20. Applicants have rewritten claims 7, 8 and 17 into independent form to incorporate the base claim and any intervening claims and the remaining claims 9 and 18-20 depend thereon. Accordingly, Applicants respectfully submit that these claims are in condition for allowance.

The rejection of claims 1-6, 10 and 15-16 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 4,928,028 to Leibovich (hereinafter "Leibovich") in view of U.S. Patent No. 4,041,336 to Sudler et al. (hereinafter "Sudler") is hereby traversed and reconsideration is respectfully requested in view of the amendments to the claims contained herein.

Independent claim 1, as amended herein, recites an electromagnetic actuator. The actuator includes a stationary assembly includes (1) a hollow stator yoke composed of a soft magnetic material and (2) two coils disposed coaxially and separately in a traveling direction of the actuator inside the hollow stator yoke. A movable assembly is disposed in a hollow space of the two coils to oppose thereto with a very small clearance. The movable assembly includes (1) a movable magnetic unit and (2) a movable yoke unit, both units mounted on a supporting shaft

adjacently to each other in an axial direction of the supporting shaft. The movable assembly travels in the axial direction by the interaction between a magnetic field generated by the movable magnetic unit and current flowing in the coils. Claims 2-6 and 15-16 depend directly or indirectly on independent claim 1.

Independent claim 10, as amended herein, recites an electromagnetic actuator. The actuator includes a stationary assembly that includes (1) a hollow stator yoke composed of a soft magnetic material and (2) a plurality of paired coils each of which is composed of two coils disposed separately in a traveling direction of the actuator inside the hollow stator yoke. A movable assembly includes the same number of pairs of a movable magnet unit and a movable yoke unit as the number of the paired coils and is disposed in a hollow space of the paired coils to oppose thereto with a very small distance. The movable assembly is mounted on a supporting shaft such that the movable assembly is movable in the axial direction of the supporting shaft. The movable assembly travels in the axial direction by the interaction between a magnetic field generated by the movable magnet unit and a current flowing in the paired coils.

The Leibovich reference discloses a proportional permanent magnet force actuator. The actuator includes first and second electromagnets, each having a cup-shaped ferromagnetic stator core with an axially extending concentric annular main pole member on the centerline thereof. An armature in the actuator is spring-biased to a neutral position and includes a disc-shaped permanent magnet configured for being received within the inner opening of the common pole and is sandwiched between first and second disc-shaped pole members. Energization of the coils simultaneously provides a first attractive force between a first armature pole and a common pole,

a repulsive force between the first armature pole and a first main electromagnet pole, a second attractive force between the second armature pole and the second main electromagnet pole and a second repulsive force between the second armature pole and the common pole. (See Abstract, col. 3, lines 15 – 30 and Fig. 3 of Leibovich).

The Sudler reference discloses a single phase stepper motor. The Office Action cites Sudler as disclosing the use of a soft magnetic material in the stator core.

Applicants' independent claims 1 and 10, as amended herein, recite at least the features of an electromagnetic actuator having a movable assembly disposed in a hollow space of two coils to oppose thereto with a very small clearance that includes (1) a movable magnet unit and (2) a movable yoke unit, both units mounted on a supporting shaft adjacently to each other in an axial direction of the supporting shaft, wherein the movable assembly travels in the axial direction by the interaction between a magnetic field generated by the movable magnet unit and a current flowing in the coils. The actuator of the present claimed invention operates according to Fleming's left hand rule applied to the mutual action between the magnetic field produced by the movable magnet unit and the current flowing in the coils. (See, for example, page 13, line 6 to page 15, line 4). In this way, the movable assembly can be brought to its target position by monitoring the current position of the movable assembly relative to the target position and continuously changing the direction and value of current according to the monitoring. In contrast, the actuator of Leibovich operates by the action of magnetic attraction and repulsion between pole members (58, 59) and the magnetic disc members (73, 74). (See, for example, Fig. 3 of Leibovich.)

Further, the actuator of Leibovich does not have a single shaft, but rather has two separate shafts 75 and 76. (See, for example, Fig. 4 of Leibovich.) In contrast, the actuator of the present claimed invention has a single supporting shaft extending in the stator yoke in its axial direction. Additionally, Leibovich's device includes spring members 64, 65 to bias the armature in a neutral position; however, such spring members are not necessary in the configuration of Applicants' claimed invention.

Moreover, in the present invention, the movable yoke unit and the movable magnet unit are mounted on the supporting shaft in a configuration that opposes the coil assemblies radially. On the other hand, in the actuator of Leibovich, the sandwiched structure of the magnetic disc members (armature poles) 73, 74 and the permanent magnet 72 attached to the shafts 75 and 76 does not oppose to the coils 60 and 61 radially, but rather opposes them in the axial direction.

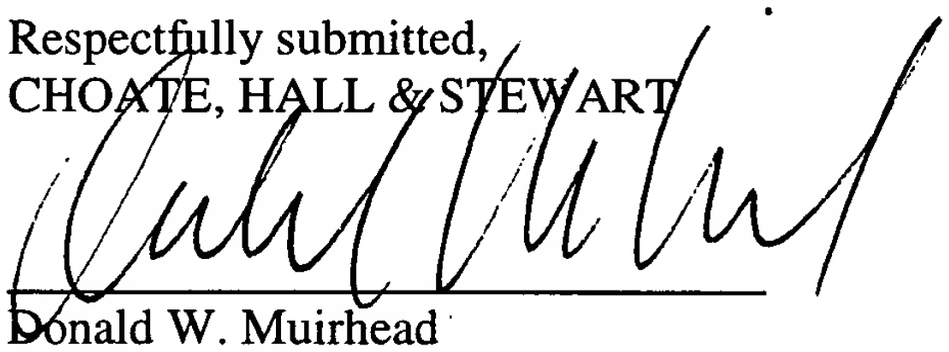
Applicants' respectfully submit that the Sudler reference does not overcome the above noted deficiencies of the Leibovich reference with respect to Applicants' claims. Specifically, Applicants respectfully submit that neither Sudler nor Leibovich, taken alone or in combination, teach or fairly suggest at least the features of an electromagnetic actuator having a movable assembly disposed in a hollow space of two coils to oppose thereto with a very small clearance that includes (1) a movable magnet unit and (2) a movable yoke unit, both units mounted on a supporting shaft adjacently to each other in an axial direction of the supporting shaft, wherein the movable assembly travels in the axial direction by the interaction between a magnetic field generated by the movable magnet unit and a current flowing in the coils. Accordingly,

Applicants respectfully request that the rejection of Applicants' claims be reconsidered and withdrawn.

Furthermore, Applicants have added new claim 21 and respectfully submit that this claim is patentable over the prior art of record.

Based on the above, Applicant respectfully requests that the Examiner reconsider and withdraw all outstanding rejections and objections. Favorable consideration and allowance are earnestly solicited. Should there be any questions after reviewing this paper, the Examiner is invited to contact the undersigned at 617-248-4038.

Respectfully submitted,
CHOATE, HALL & STEWART



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